# Chemical Analysis of Stones in Layers - A Study of 102 Stones at Mayo Hospital, Lahore

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**The chemical composition of 102 urinary stones was determined in layers (Three or two) by means of a Merckognost reagent kit by Merck, Germany. Out of 102 Calculi, 22 (21.5%) were pure stones i-e Calcium oxalates(19.8%) and uric acid(1.9%) and 80 (78.4%) were a mixture of two or more compounds. Calcium oxalate was the commonest constituent of pure as well as mixed stones.**

**Key words Urolithiasis, Chemical analysis**

A study of chemical composition of urinary calculi is important for the understanding of their etiology, management and prevention of recurrence. Crushing the whole stone followed by the analysis of the pulverized material has been carried out in most of the studies. A large number of stones are of mixed composition, consisting of nucleus and many surrounding layers of different colors and varying composition. The nucleus of the stone is indicative of the initial metabolic disorder and it is advised that stone should be analyzed in layers[1]. Shahjehan and Rehman are probably pioneers in analyzing stone in layers in Pakistan[2].

There are different methods of stone analysis are available but chemical analysis has been the most widely used method, chemical methods being simple and having only 2% error in detection of composition of stone. The present study was conducted to carry out chemical analysis of the 102 stones in layers.

**Methods and Materials:**

This study was carried out in the Department of Urology, Mayo Hospital, Lahore from January 98 to December 98. Study was prospective and included 102 cases of kidney, ureter and bladder stones. Patients of all ages and either sex were included in the study. Small stones i-e less than 0.9 cm were excluded from the study.

Detailed history, general physical examination and examination of the genitourinary tract was performed. Routine investigations included complete blood and urine examination, particular emphasis was placed on the number and type of urinary crystals seen on microscopy. Blood urea and serum creatinine were determined to assess the functional status of the kidneys. Ultrasonography of the KUB area was performed to see the size and site of the stones as well as it showed any other abnormality of the urinary system like degree of hydronephrosis, echotexture of kidneys, cortical thickness and diverticula, if any in the urinary bladder. Intravenous urography was performed to confirm the findings of ultrasonography and also to assess the function of the kidneys.

Stones recovered after either open or endoscopic surgery were biochemically analyzed using Merckognost reagent kit (Cat. No. 1.11003.0001) by Merck, Germany. The recovered stones were divided in the middle into two parts, then central nucleus of the stone was scooped out with a knife, and the surrounding middle portion was scratched out, leaving behind the outer zone. These three zones were chemically analyzed. Larger stones were analyzed in three i.e., outer, middle, and central layers. However in case of smaller stones not less than 0.9cm, it was difficult to obtain three layers, hence these were analyzed in two i.e., the central and outer layers.

Basically two methods were used for final composition determination. First was Titrimetric method, in this method a reagent (Titriplex III Soln) was titrated against the sample and the quantity of this reagent consumed in the process was used to determine the composition of calcium. Second method was calorimetric which involves a change in color of the sample when different reagents were added to the small reaction vessel. The color was then compared with a standard color chart and composition of the rest of the components i-e oxalate, phosphate, magnesium, ammonium, uric acid and cystine was determined.

The final composition of the urinary calculus was obtained from these determinations with the help of a calculation aid provided with the Merckognost kit.

**Results**

Out of 102 cases, 68(66%) patients were male and 34 (33%) were females, with male to female ratio 2:1. The age of the patients ranged between 2- 80 years, with the mean age of 38.5 years.

From a total of 102 stones, 70(68.6%) were renal, 7(6.8%) ureteric and 25(24%) were bladder calculi. Size of the stones varied from 0.9cm to 7.5cms. The largest stone was found in the urinary bladder, may be because of its larger capacity. In our series 61% patients belonged to urban, while 39% belonged to rural area. All patients underwent open surgery except one case where endoscopic surgery was performed.

From a total of 102 calculi ,22 (21.5%) were found to be pure stones and 80 (78.5%) were a mixture of two or more compounds. Of the 22 pure calculi, 20 (19.6%) were

composed of calcium oxalate, while 2 (1.9%) were of pure uric acid. In case of mixed stones, calcium oxalate was the commonest compound, present in 91% of the stones in the outer layer, 94% in the middle layer and 89% in the inner layer, almost equal percentage in all the three layers. Compounds of phosphate occurred more often on the surface (39.9%) and middle layer (41%), than in the center (27%). In contrast, uric acid occurred on the surface of the stones in 35%, in the middle layer 54.8% and in the central layer 56.6% (Table 1&2).

**Discussion:**

Many studies on the urinary stone analysis have been carried out in Pakistan. Stone analysis by contemporary method in our study revealed 22(21.5%) pure calculi, out of these, 20 (19.6%) were pure calcium oxalate, while only 2(1.9%) revealed pure uric acid. In Israel 40% of the stones were composed of uric acid 25 years ago, now only 19% are composed of pure uric acid[3]. In Saudi Arabia uric acid stones comprised 11.5-12%[4], while in Italy[5] it constituted 26% and 14% in Germany[5]. Results from Estonia revealed that 53% of the stones were uric acid in 1985[6] and reduced to 33% in 1995[6]. Low incidence of pure uric acid stones in our population may be due to low consumption of meat and meat products. We use more vegetables, the risk of uric acid stone formation is three fold lower in vegetarians[7].

. In our study only 19.6% of the total stones were found to be pure calcium oxalate, most of the studies carried out in Pakistan also exhibited pure calcium oxalate stones in the range of 20 - 30%. Whereas studies from oil rich states of Middle East,(Kuwait, U.A.E & K.S.A.) declared higher incidence of pure calcium oxalate in upper tract urolithiasis[8]. Chemical analysis of 514 urinary stones conducted at the King Khalid University Hospital Riyadh, over one year period (1985-1986) demonstrated that 81.5% were pure calcium oxalate stones. Pure calcium oxalate stones are also common in the Western World, but percentage is less as compared (60-70%), oil rich states of Middle East[9]. These variations largely reflect wide variety of dietary and cultural differences.

In Pakistan majority of the stones are also calcium oxalate with urate as a second commonest constituent. Shahjehan and Rehman[2] have demonstrated that about 50% of the renal calculi were of mixed composition and 35% were pure calcium oxalate. Layer by layer stone analysis showed that most of the stones were of mixed variety and calcium oxalate was present in 90% of the stones. The surprising finding was that urate was also present in 80% of the samples. Our study revealed 56.6% of uric acid in the central layer in the upper tract stones and upto 64% in case of lower tract stones. Another finding in the Shahjehan's study was that the nucleus of the bladder and of the renal calculi were of same composition, while surrounding layers were of different composition which almost correspond to our results except that the uric acid was found to be in higher percentage of patients in lower tract stones in our study.

Table 1. Analysis of 102 stones (in layers ) by chemical method

| Composition | Outer Layer (No.of Pts) | Middlelayer (No.Of Pts.) | Inner Layer (No.of Pts) |
|---|---|---|---|
| Ca + OX | 39 | 9 | 25 |
| Ca + OX + UA | 21 | 20 | 42 |
| Ca + OX + P | 23 | 14 | 19 |
| Ca + OX + UA + P | 10 | 5 | 05 |
| Ca + P + UA | 3 | 1 | 4 |
| UA | 2 | 2 | 3 |
| Mg + NH4 + P | 3 | 00 | 00 |
| Ca + P + HCO3 | 1 | 00 | 00 |
| UA + NH4 | 00 | 00 | 4 |

Table 2. Percentage and composition of 102 stones

| Composition | Outer Layer (No.Of Pts) | Middlelayer (No.Of Pts.) | Inner Layer (No.Of Pts) |
|---|---|---|---|
| Ca + OX | 91% | 94% | 89% |
| P | 39.95% | 41% | 27% |
| UA | 35% | 54.8% | 56.6% |

Ca = CALCIUM OX = OXALATE
UA = URIC ACID P = PHOSPHATE

**Conclusion:**

Majority of the stones are of mixed variety, with calcium oxalate as a predominant constituent in all the three layers and uric acid content increasing gradually from outer to middle and the central layer.

Pure stones occur less commonly as compared to mixed stones, nevertheless pure calcium oxalate are more common than the pure uric acid stones.

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